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RESEARCH-CLINICAL

Is There Any Role of Resecting the Stomach to Ameliorate Weight Loss and Sugar Control in Morbidly Obese Diabetic Patients?

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Abstract
Background Among the restrictive procedures the role of restrictive vs. resecting the stomach is still ambiguous. This study evaluate which is the role of the stomach with respect to blood glucose levels (BG) and percent excess weight loss (EWL) over the 18 months after restrictive procedures in morbid obese diabetic patients.
Methods We retrospectively compared a group of patients who underwent partial gastrectomy (just part of the gastric body) with gastric banding (GBSR; n=27), sleeve gastrectomy (part of gastric body and complete fundus resection; LSG; n=53) to laparoscopic gastric banding (LAGB; n=100). Differences among groups at 3, 6, 12, and 18 months were evaluated by analysis of variance. The three cohorts were diabetic patients similar in BMI, age, and gender.
Results At 12 and 18 months, LSG had higher EWL (P< 0.05) and lower BG (P<0.05) than did either LAGB or GBSR. There were no operative deaths. Complications: LAGB—two staple-line oozing, two wound infections; LSG—one hemorrhage, two staple-line oozing, two leaks; GBSR—one hemorrhage, two wound infections. All complications were readily treated.
Conclusions LSG provides better weight loss and glucose control at 1 year and 1.5 years after surgery than does either LAGB or GBSR, suggesting that gastric fundus resection plays an important, not yet well-defined, role.

Keywords Morbid obesity · Diabetes type II · Metabolic syndrome · Sleeve gastrectomy

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Introduction

A bariatric surgery meta-analysis evidenced the efficacy for bariatric surgery's ability to ameliorate diabetes mellitus and to reduce weight in morbidly obese patients [1]. Hu et al. concluded that the majority of Type II DM cases could be ameliorated through weight loss, regular exercise, diet modification, abstinence from smoking and limited alcohol consumption, where weight-loss would yield the greatest benefit [2]. Others like Pinkney et al. have agreed bariatric surgery to be the best solution to long-term weight loss [3]. Pories et al. first suggested that Type II DM could be controlled with surgery [4]. It has been reported that actions of gastric bypass (GB) and biliopancreatic diversion (BPD) showed to successfully control Type II diabetes mellitus [5]. The role of the stomach in the restrictive procedures has not been considered before. Many authors have reported the excellent results of bariatric surgery on weight and sugar control [6–19] with particular attention to the role of gastric banding and sleeve gastrectomy.

This retrospective study compares laparoscopic sleeve gastrectomy (LSG), laparoscopic adjustable gastric banding (LAGB), and combined gastric banding/partial gastrectomy (GBSR) of the body only. We evaluated, with respect to post-operative glucose levels and percent excess weight loss (EWL), to see if there were any differences among the procedures which have different-sized stomach resection (Fig. 1).

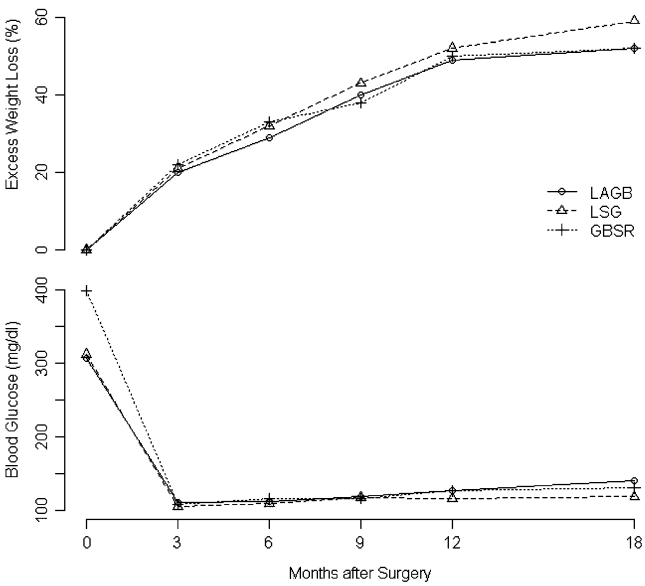

Fig. 1 Percent excess weight loss and blood glucose levels by time after surgery and by bariatric procedure for 100 patients who underwent laparoscopic adjustable gastric banding (LAGB), for 53 patients who underwent laparoscopic sleeve gastrectomy (LSG) and for 27 patients who underwent combined gastric banding/gastric resection (GBSR)

Materials and Methods

This retrospective IRB study compared a group of patients who underwent partial gastrectomy (just part of the gastric body) with gastric banding (GBSR; n=27), sleeve gastrectomy (part of gastric body and complete fundus resection; LSG; n=53) to laparoscopic gastric banding (LAGB; n=100), for a total of 180 patients, performed between 2004 and 2008 in obese and diabetic patients.

Differences among groups at 3, 6, 12, and 18 months were evaluated by analysis of variance. The three cohorts were diabetic patients similar in BMI, age, and genders.

Patients with fasting glucose level above 250 mg/dl were included in these chart reviews. All techniques have been described previously [20–22]. The LAGB was placed using the pars flaccida technique. A five-port technique was used; the reflexion of the peritoneum was visualized on the right crura of the diaphragm and dissected. The band was then passed around the stomach locked and secured in placed with three non-absorbable stitches. The port was secured to the fascia with four non-absorbable stitches. All the bands were from Allergan (Inamed; Irvine, CA). We have used the Van Guard band® for the GBSR group, either the same band or the 10-cm band in the last year. In LSG, the stomach was resected from the antrum, including the fundus [21]. Full dissection of the greater omentum was achieved to visualize the left crura. The dissection started by stapling the stomach out over a 29 French bougie, 8–10 cm from the pylorus. The stomach was retrieved. In GBSR, gastric banding was first completed according to the pars flaccid technique briefly described above. Then the stomach was stapled out starting 8 cm from the pylorus and up to the band already inserted [20]. Therefore the band was not placed on top of a stapler line which could have been caused break down of the balloon.

Reinforced green (Covidien, Norwalk, CT) staples were used with Peri-strips (Synovis, St. Paul, MN) or Seam-Guard (W.L. Gore and Associates, Inc., Newark, DE). Surgeries were performed in different hospitals by the same surgeon. DVT prophylaxis was given according to our protocol with mini-Heparin pre- and post-operatively [23]. Upper GI was performed in the morning [22]. After surgery, median follow-up was 18 months, with consultations and obtaining of weight and glucose measurements at 3, 6, 12, and 18 months post-operatively which are basic measurements after bariatric surgery. HgA1C was measured inconsistently among the group and therefore the data was eliminated from the analysis. Analysis of variance compared groups, with null hypotheses being rejected when $P<0.05$.

Results

Charts were reviewed for 100 LAGB patients, for 53 LSG patients, and for 27 GBSR patients. We have followed-up, at 18 months, a total of 76 patients after LAGB (76% follow up), 46 of the LSG patients (86% follow up), and 22 patients in the GBSR group (81% follow up). Patient characteristics are summarized in Table 1. There were no operative deaths. Complications for GBSR included two cases of staple-line oozing and two wound infections. Complications for LSG included two cases of staple-line oozing, one case of staple-line hemorrhage, and two leaks. Complications of LAGB included two wound infections (Table 2). All bleeding was readily controlled with fresh frozen plasma (FFP). Figure 1 and Tables 3 and 4 display

Table 1 Summary of our patients

Variable	Surgical procedures		
	LAGB	LSG	GBSR
Male	12	11	5
Female	88	42	22
Mean age (in years)	42	51	37
BMI (kg/m^2)	50.1	53.5	51.3
Operating room time (min)	45	70	92
% EWL @ 12 months	52	52.2	50
% EWL @ 12 months	9	59.2	52
Co-morbidities	9	12	9

Table 2 Complications after LSG

Variable	Surgical procedures		
	LAGB	LSG	GBSR
Bleeding	0	1.8 (n=1)	4.5 (n=1)
Oozing	2% (n=2)	3.7% (n=2)	0
Leaks	0	3.7% (n=2)	0
Return to operating room	0	5.6% (n=3)	5% (n=1)
Wound infection	2% (n=2)	0	2% (n=2)

mean post-operative EWL and BG values by procedure. ANOVA showed that LSG was superior to LAGB and GBSR at 12 and 18 months (P<0.05 for each analysis).

Discussion

Low mortalities and significant decreases in co-morbidities help quantify the benefits of bariatric procedures, which include glucose stabilization and short- and long-term weight loss. This study found LSG was superior to both LAGB and GBSR with respect to both parameters at 12 and 18 months. The results are at variance with prior studies. Himpens et al. showed the weight loss at 3 years to be similar in LAGB and LSG procedures [24]. Some authors [16, 25] showed the %EWL at 5 years to be similar in LRYGB and LAGB. Others reported good control of diabetes with LAGB only [14]. Our follow up at 18 months is a good average for bariatric patients even though we were hoping to report the data at 5 years to have a better understanding of the process. We think that the LSG patients preferred follow up with our office since it was a new procedure; while for the LAGB group some patients decided to have the filling and the follow up closer to home, given the distance from our location.

Langer et al. [26] showed that weight loss following LSG was larger than that following LAGB and ghrelin changes were more prominent with LSG. Moon [27] found SG yielded a mean EWL of 71% with complete DM resolution in all patients. LSG has also been shown to shorten the time for half a solid meal to proceed from the stomach to the duodenum, a finding that supports the facilitation of gastric emptying with pylorus preservation [28]. We think that our results varied from the literature a little since we considered and focus on the removal of the stomach which was performed over a 29 French bougie. We were actually not surprised to find that the LSG patients did so well given the “ghrenilectomy” procedure that we performed by removing the fundus of the stomach.

Table 3 Percent effective weight loss in %

Months	3	6	9	12	18
LAGB	20	29	40	49	52
LSG	21	32	43	52	59
GBSR	22	33	38	50	52

Table 4 Blood sugar levels in mg/dL

Months	Pre-op	3	6	9	12	18
LAGB	307 ±21	110 ±15	111±17	118±22	127±19	140±21*
LSG	312±26	105±14	109±19	117±21	116±20	118±20
GBSR	398±18	108±13	116±20	116±18	126±21	130±18 **

*P<0.005 at 18 months (LSG vs LAGB)

**P<0.005 at 18 months (LSG vs GBSR)

Our explanation about our unusual result focuses on the effect of removing the fundus of the stomach, which probably produces a hormonal response which affects both the EWL and the long-term control of diabetes. This potential explanation matches what was reported earlier by Frühbeck who showed that it is the degree of dysfunctionality of the stomach that has an effect on hormonal secretion [29]. The stomach is the major producer of ghrelin [30] and enterohormonal changes are quite common after bariatric surgery [31]. In the stomach, ghrelin is produced mainly in the fundus and a little in the body [32–35]. By resecting the fundus, we have better results in both EWL and a significantly better (P<0.05) glucose control after LSG. The effect of gastric surgery on ghrelin [34] has been evaluated in the past but nobody has connected the role of the gastric fundus resection to % EWL and sugar level. We do not know if it is the partial vagotomy of the LSG that produces the effect on EWL and blood glucose by increased stomach peristalsis [36] despite an intact pylorus [28] but no clear study came out on vagal pacing in stomach experiment [35–37], although it is thought to increase vagus output in the stomach passage [38]. We also know that the weakness in our study is the lack of HgC1A level in every group, but we think that even without it, the message of the paper could still have its importance.

Conclusion

At 12 and 18 months after surgery, sleeve gastrectomy is superior, with respect to glucose control and weight loss, to either gastric banding or combined gastric banding/partial gastrectomy. The exact mechanisms for this finding remain to be elucidated. Our hypothesis stands on a mechanism related to stomach fundus removal and neurohormonal control mechanism.

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